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(54) Title: SYNTHETIC YARN WITH HEAT-ACTIVATED BINDER FIBER

(57) Abstract

Synthetic yarn comprises a blend of base fiber selected from the group consisting of polyester, nylon-6 and nylon 6,6 and 1-12 weight percent, preferably 1-8 weight percent, of a heat activated binder fiber with a melting point within the range of 110-170°C, preferably 130-160°C. A preferred binder fiber is a copolyamide fiber, including ternary copolyamides of the 6/66/12 type. When the yarn is twisted, plied and twist set by conventional processes and the treated yarn tufted into carpet, the resulting carpet displays enhanced wear and appearance properties.

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SYNTHETIC YARN WITH HEAT-ACTIVATED BINDER FIBER

1. Field of the Invention

The invention relates to synthetic yarn for carpet face fiber and other applications, the yarn comprising a blend of fibers including a first synthetic base fiber and a second heat-activated adhesive fiber with a melting point substantially below that of the first synthetic base fiber. In a process for production of carpet, exposure of the yarn to usual process conditions for twist setting the yarn causes the heat-activated adhesive fiber to melt substantially completely, losing its identity as a fiber, and to flow to points of intersecting base fibers to create a bond upon subsequent cooling, thus altering properties and performance of the resulting product.

2. Description of Related Art

It has been known to blend non-adhesive fibers with potentially adhesive fibers to form a yarn or other textile structure, then to activate the potentially adhesive fibers to bond them to contacting fibers, thus modifying end-use properties of the yarn. U.S. Patent 2,252,999 to Wallach, issued August 19, 1941, provides a process wherein a yarn comprising an admixture of non-adhesive and potentially adhesive fiber is formed, the potentially adhesive fiber is activated, and the fibers compacted while in an adhesive condition so that they adhere to each other at points of contact. U.S. Patent 3,877,214 to Van der Werf, issued April 15, 1975, discloses a twist-free yarn comprising a polyamide fiber melting under a relatively low temperature as a bonding component. U.S. Patent 3,494,819 to McAlister, issued February 10, 1970 discloses a blend of fusible and non-fusible polyethylene terephthalate fibers incorporated into fabric, wherein the finished fabric is heated to fusion temperatures to provide improved pill resistance. U.S. Patent 3,978,267 to Selwood, issued August 31, 1976 discloses a substantially twistless compact yarn comprising a proportion of potentially adhesive fiber which have been activated to bond to contacting fibers.

The use of thermoplastic binder fibers in combination with structural fibers to form self-bonding nonwoven fabrics is known. U.S. Patent 2,880,112 to Drelich, issued March 31, 1959 discloses the use of nylon-6 to bond viscose rayon and other cellulosic materials to form washable nonwoven fabrics.

Cut-pile carpet is customarily produced from staple yarns or bulked continuous filament yarn. For example, staple fiber is conventionally carded, pinned, and spun or wrap spun into a singles yarn, which typically is twisted and plyed with similar yarn to form a 2-ply or 3-ply yarn construction. This yarn is twist set by utilizing one of several commercially available twist setting processes. In a typical process the yarn is passed through a heated chamber, while in a relaxed condition. The temperature of this process step is crucial to the proper twist setting of the base fiber, to obtain desired properties of the final carpet product. For nylon-6 base fiber, the conditions for this step are typically 195-200° C with a residence time of about 60 seconds for the Suessen process and about 135-140° C with a residence time of about 60 seconds for the Superba process.

Similarly, bulked continuous filament nylon yarn is produced according to various conventional methods. Twisting, entangling, or direct cabling may be utilized in various processes. For example, a 2-ply twisted yarn combining 2 ends of 1185 denier 70 filament yarn is prepared and subjected to conventional twist setting conditions, such as that for the staple yarn above or in an autoclave at 132° C in saturated steam, with a residence time of about 60 seconds.

Multiple ends of the twist set yarns are tufted into cut pile carpet and conventionally finished to obtain the desired carpet product.

SUMMARY OF THE INVENTION

Synthetic yarn comprises a blend of base fiber selected from the group consisting of polyester, nylon-6

and nylon 6,6 and 1-12 weight percent, preferably 1-8 weight percent, of a heat activated binder fiber with a melting point within the range of 110-170° C, preferably 130-160° C. A preferred binder fiber is a copolyamide fiber within the specified melting point range. Ternary copolyamides of the 6/66/12 type are examples of preferred binder fibers. When the yarn is twisted, plyed and twist set by conventional processes, for example 195° C for a residence time of about 60 seconds, and the treated yarn tufted into cut-pile carpet, the resulting carpet displays enhanced carpet tuft appearance, improved resilience, and reduced change of appearance with use.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Applicant has discovered that by incorporation of a minor proportion of heat-activated binder fiber with substantially lower melting point than the base fiber into the yarn construction, the standard heat conditions for twist setting the yarn will cause the binder fiber to melt, substantially loosing its identity as a fiber. It will flow to intersecting points of base fiber and upon subsequent cooling will encapsulate and bind fibers and yarn together, thereby retaining the twist in cut-pile carpets. Carpets made with the yarn of this invention can be improved in surface, aesthetics, hand, durability and wear performance. By careful selection of the binder fiber desired improvement is "built-in" to the yarn, with no additional process steps required by the yarn spinner, the carpet manufacturer, or in dyeing and finishing.

The base fiber is selected from known synthetic fiber suitable for carpet use. Preferred base fiber includes polyamide, particularly nylon-6 and nylon-6,6, and polyester, particularly polyethylene terephthalate.

The binder fiber is selected to provide good adhesion to the base fiber. It is important that the melting point of the binder fiber be in the range of 110-170° C, preferably 130-160° C, under ambient humidity conditions. This range ensures that the binder fiber will melt during the conventional twist setting process yet

will provide adequate adhesive properties during any subsequent dyeing steps and final use. A saturated steam environment, such as in an autoclave, reduces the fiber melting point dramatically.

A preferred class of binder fiber for use with polyamide base fibers are copolyamides within the specified melting point ranges. Suitable copolyamides of the 6/66/12 type and a process for their production are disclosed in U.K. Patent 1,168,404, issued October 22, 1969 to Inventa A. G., incorporated herein by reference. A melt bonding copolyamide adhesive fiber is commercially available from EMS as GRILON® type K 140 (melting range 130-140° C) and type K 115 (melting range 110-117° C).

The binder fiber can be blended with base staple fiber, and the resulting staple fiber blend can then be processed in known ways. It is important to insure a thorough blending to avoid potential clumps in the finished carpet. The staple fiber blend should contain 1-12 weight percent binder fiber, preferably 1-8 weight percent. Higher amounts cause undesirable harshness of hand due to the conditions of the twist setting process causing the binder fiber to melt substantially completely. Spun yarns prepared from such a staple fiber blend and subjected to thermal activation can provide strength properties approaching that of bulked continuous filament (BCF) yarns. Properties of BCF yarns can also be enhanced.

By selection of the thermally activated binder fiber within the weight ranges and melting point ranges specified it is possible to modify end-use properties of the finished carpet to improve wear resistance, resilience, reduced change of appearance over time and with use, and increased hand, lustre and apparent value. Denier per filamant, cut length, fiber cross-section, crimp type and frequency, surface finish, melt viscosity, softening point, melting point, dye affinity, and other properties are crucial to achieving ideal properties in the final product. A proper selection of the binder fiber

must be made to obtain the desired, or optimum results from the finished carpet product. This will depend on numerous factors including the denier, length, crimp, finish, and other properties of the base fiber product.

With the utilization of this invention, twist setting conditions normally used are sufficient to activate the binder fiber, to create bind points which strengthen the final product, thereby imparting other characteristics which are desirable. For the Suessen process, under relatively low humidity conditions, the twisted yarn is subjected to a temperature of 190-205° C for a residence time of 50-60 seconds. In the Suessen process motion of the fiber while in the relaxed state, caused by vibration or air currents, sufficiently motivates the molten binder fiber to flow to the intersecting "touch points" of the base fiber, as a function of the melt flow properties of the binder fiber and surface characteristics. As the fiber emerges from the elevated temperature condition, the binder solidifies and encapsulates or bonds two or more base fibers together at intersecting points in a durable bond.

Subsequent processing including dyeing, finishing, and backcoating using commercial processing methods does not soften the bond points sufficiently to weaken them, but rather will strengthen them. The resultant carpet can be of many forms, but a typical style would be cut-pile carpet with about 40 ounces per square yard of face yarn including the binder, with an attached backing. Carpet construction would be typically 5/32" gauge, 3/4" pile height, and the carpet would be dyed, dryed, backcoated, and sheared using normal processing techniques. The yarn of the invention would also provide important property improvements in the production of loop-pile carpet.

EXAMPLE 1

A blend of staple fiber was produced with 3 weight percent GRILON® Type K 140 copolyamide fiber having a melt point range of 130-140° C and 97 weight percent base

staple fiber (Allied Type 521 nylon-6 fiber having a melt point range of 215-225° C).

The blended fiber was carded, pinned and spun into a singles yarn by conventional processing methods. The yarn, a 3's cotton count yarn containing 4.7 "Z" twists per inch, was plyed with a similar yarn to produce a 2-ply 3's/2 cotton count 4.7Zx4.0S yarn.

The 2-ply yarn was twist set by a conventional Sussen twist setting process. The yarn was passed through a heated chamber at about 195° C while in a relaxed condition, with a residence time of about 60 seconds.

Multiple ends of this yarn was tufted into cut pile carpet and conventionally finished to obtain the improved product.

The resulting carpet was compared to a control carpet prepared in the same manner from 100 percent base staple fiber. The carpet containing the binder staple fiber blend displayed enhanced carpet tuft appearance, more resilience, and better wear resistance.

EXAMPLE 2

Carpets also may be produced from bulked continious filament (BCF) yarns, and carpets thus made can be improved in surface, aesthetics, hand, or in durability and wear by using this invention. In the following example the carpet manufacturer simply uses normal processing techniques to obtain the desired effect.

Filament nylon yarn is produced according to various conventional fiber producer manufacturing methods. These methods are not particularly related to the invention, except that another, smaller, filament yarn will accompany a base yarn throughout subsequent process steps. Often the combination will result in a 2-ply, 3-ply, or other form needed for the carpet style.

In various processes, twisting, entangling, or direct cabling may be utilized. Direct cabling is often used, as in this example, where a 70 denier 14 filament yarn is combined with a 1185 denier 70 filament in the creel of the direct cabler to produce a yarn with 3.5 "S"

twist per inch in each of the singles and 3.5 "Z" twist in the resultant 2-ply twisted yarn (1185 x 2 ply). The final yarn contains a third component, a binder yarn, which has a lower melting point and which will lose much of its identity in subsequent process steps, as it is melted and flows to bind fibers and yarn together, thereby retaining the twist in cut pile carpet.

In this example a copolyamide 70 denier nylon yarn having a melt point range of 130-140° C results in the binder fiber for the combination, combined with 2 ends of 1185 denier, results in a blend of about 2.8 percent binder. This ratio can be doubled by using two ends, or varied by providing other denier products to the system.

When the product is subjected to conventional twist setting, the binder is activated producing a final product with the desirable characteristics of enhanced carpet tuft appearance, more resilience, and better wear resistance than similiar carpets not containing the binder. The twist setting conditions for this are typically 270° F, in saturated steam, with a residence time of about 60 seconds. As the fiber emerges from the elevated temperature condition, the binder solidifies and encapsulates or bonds two or more base yarns together in a permanent or durable bond.

Multiple ends of these yarns are tufted into cut pile carpet and conventionally finished to obtain the improved product.

WHAT IS CLAIMED:

1. Synthetic yarn for carpet face fiber comprising:

a. base fiber selected from nylon-6, nylon-6,6, and polyester;

b. 1-12 weight percent heat-activated binder fiber with a melting point range of 110-170° C under ambient humidity conditions.

2. The yarn of claim 1 wherein said binder fiber has a melting point range of 130-160° C.

3. The yarn of claim 2 comprising 1-8 weight percent binder fiber.

4. The yarn of claim 1 wherein said binder fiber is a copolyamide.

5. The yarn of claim 4 wherein said binder fiber is a ternary copolyamide of the 6/66/12 type.

6. The yarn of claim 5 wherein said binder fiber has a melting point range of 110-150° C.

7. The yarn of claim 6 comprising 1-8 weight percent binder fiber.

8. The yarn of claim 7 wherein said base fiber is nylon 6.

9. A process for production of carpet comprising heating the yarn of claim 1 sufficiently to substantially melt said binder fiber, then subsequently cooling said yarn to solidify said melt, thereby encapsulating and bonding intersecting points of said base fiber; then incorporating the heat-treated yarn into the carpet construction.

10. The process of claim 9 wherein said heating step is accomplished during twist setting of said yarn.

11. A process for production of carpet comprising heating the yarn of claim 4 sufficiently to substantially melt said binder fiber, then subsequently cooling said yarn to solidify said melt, thereby encapsulating and bonding intersecting points of said base fiber; then incorporating the heat-treated yarn into the carpet construction.

12. The process of claim 11 wherein said heating step is accomplished during twist setting of said yarn.

13. A process for production of carpet comprising heating the yarn of claim 5 sufficiently to substantially melt said binder fiber, then subsequently cooling said yarn to solidify said melt, thereby encapsulating and bonding intersecting points of said base fiber; then incorporating the heat-treated yarn into the carpet construction.

14. The process of claim 13 wherein said heating step is accomplished during twist setting of said yarn.

15. A process for production of carpet comprising heating the yarn of claim 6 sufficiently to substantially melt said binder fiber, then subsequently cooling said yarn to solidify said melt, thereby encapsulating and bonding intersecting points of said base fiber; then incorporating the heat-treated yarn into the carpet construction.

16. The process of claim 15 wherein said heating step is accomplished during twist setting of said yarn.

17. A process for production of carpet comprising heating the yarn of claim 7 sufficiently to substantially melt said binder fiber, then subsequently cooling said yarn to solidify said melt, thereby encapsulating and bonding intersecting points of said base fiber; then incorporating the heat-treated yarn into the carpet construction.

18. The process of claim 17 wherein said heating step is accomplished during twist setting of said yarn.

19. A process for production of carpet comprising heating the yarn of claim 8 sufficiently to substantially melt said binder fiber, then subsequently cooling said yarn to solidify said melt, thereby encapsulating and bonding intersecting points of said base fiber; then incorporating the heat-treated yarn into the carpet construction.

20. The process of claim 19 wherein said heating step is accomplished during twist setting of said yarn.

INTERNATIONAL SEARCH REPORT

International Application No PCT/US 87/02339

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) [6]

According to International Patent Classification (IPC) or to both National Classification and IPC

IPC[4]: D 02 G 3/40

II. FIELDS SEARCHED

Minimum Documentation Searched [7]

Classification System	Classification Symbols
IPC[4]	D 02 G

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched [8]

III. DOCUMENTS CONSIDERED TO BE RELEVANT [9]

Category [10]	Citation of Document, [11] with indication, where appropriate, of the relevant passages [12]	Relevant to Claim No. [13]
X	FR, A, 2124919 (I. & P. COATS LTD) 22 September 1972 see page 2, lines 1-13, 16-20; page 3, lines 11-13, 17-23; page 6, lines 17-19	1-3,9
Y		4-8,11,13, 15,17,19
X	US, A, 3494822 (L.H.P. WELDON) 10 February 1970 see column 1, line 46 - column 2, line 9, lines 47-56	1-3
Y	GB, A, 1168404 (INVENTA AG) 22 October 1969 see page 2, lines 4-6 cited in the application	4-8,11,13, 15,17,19

* Special categories of cited documents: [10]

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"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

IV. CERTIFICATION

Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report
16th December 1987	10 FEB 1988
International Searching Authority: EUROPEAN PATENT OFFICE	Signature of Authorized Officer: P.C.C. VAN DER PUTTEN

ANNEX TO THE INTERNATIONAL SEARCH REPORT ON INTERNATIONAL PATENT APPLICATION NO. US 8702339 SA 18888

This annex lists the patent family members relating to the patent documents cited in the above-mentioned international search report.
The members are as contained in the European Patent Office EDP file on 28/01/88
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